

3. ARES MWIR SPECTROMETER

The ARES MidWave InfraRed (MWIR) Spectrometer, which is owned by the US Air Force, was originally designed for studying missile plume measurements. However, its wavelength coverage from 2.0 to 6.4 μm makes it useful for the exploration of various infrared phenomena.

The ARES instrument is designed around a 45 x 90 element Si:In focal plane array which operates at cryogenic temperatures within a helium dewar. The relative spectral response of Si:In (at 73K) is shown in Figure 2.^[7] The optical elements provide a pixel IFOV of slightly more than 1 mrad. The normally-used 45 x 45 pixel square image is approximately 52 mrad square. Operated as an imaging spectrometer, a narrow slit (approximately 0.3 mrad wide) provides relatively high instantaneous spatial resolution in one direction, with the slit image dispersed across 75 pixels from 2.0 to 6.4 μm , providing individual column spectral bandwidths, ranging from 20 to 70 nm, depending on the column. Table 2 lists the noise-equivalent spectral radiance for selected spectral columns.^[5] The spectrometer's spatial resolution is determined by frame rate and ground speed. For example, it is two meters at a frame rate of 80 Hz and a speed of 310 kt.

The aircraft has been modified with externally mounted optics as well as internally mounted optics as shown in Figure 3.^[5] A stabilized external mirror is used to point the field of view in the desired direction. Light is reflected off the main pointing mirror into a dichroic beamsplitter so that the IR energy is reflected down into the instrument, while the visible is allowed to pass through to a pair of TV tracking cameras. The IR energy is split by a 75/25 IR beamsplitter, so that a portion is reflected into a SWIR TV camera, also used for tracking. The remainder is reflected off a fine-scan mirror into the entrance window of the main telescope dewar. The internal optical elements of the telescope dewar are held at liquid nitrogen temperatures to reduce noise caused by thermal radiation.

The spectrometer optics are shown in Figure 4.^[5] From the primary mirror, light is reflected off the secondary mirror onto the edge of a narrow reflective "slit" back to the secondary mirror, and back to the opposite side of the primary mirror. From there light is reflected off a flat fold mirror through a biprism assembly, and the dispersed light enters the focal plane dewar.

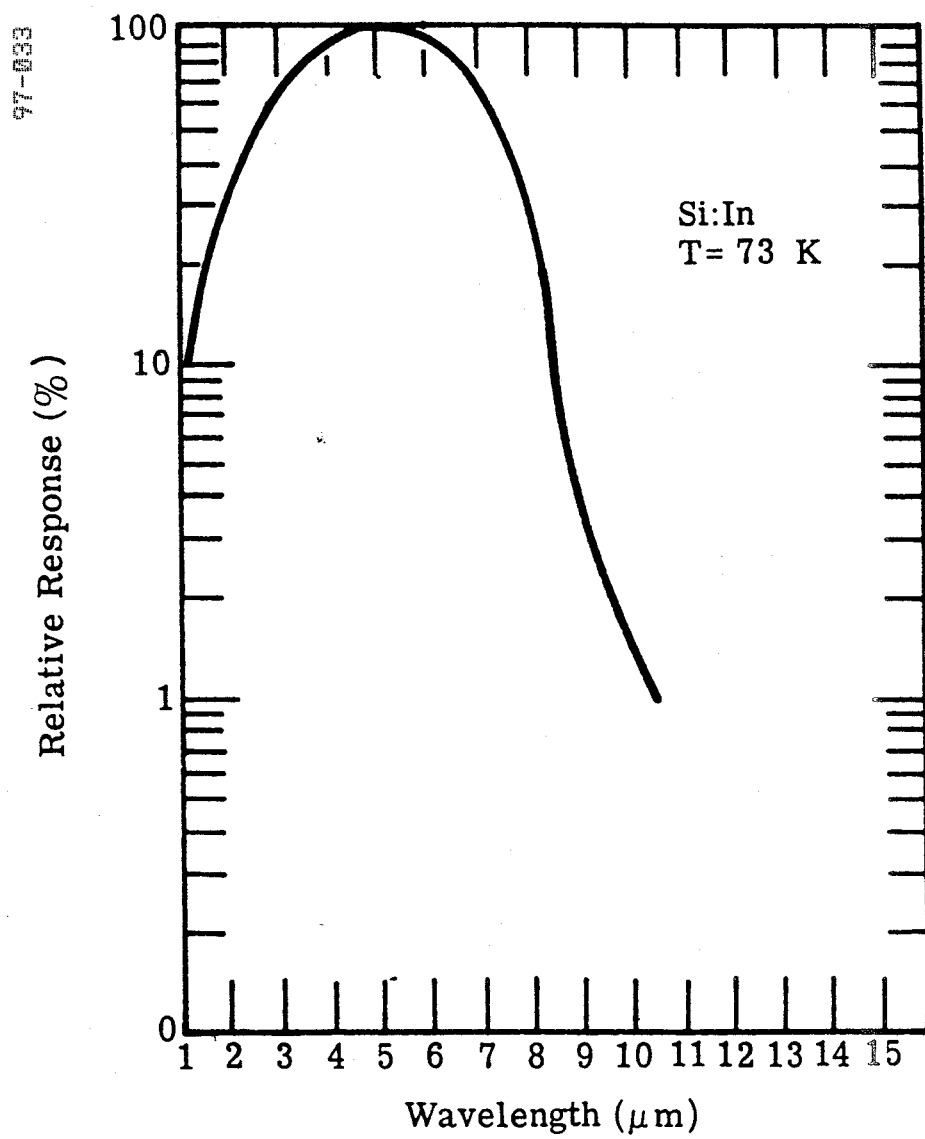


Figure 2. Spectral Response of Si:In

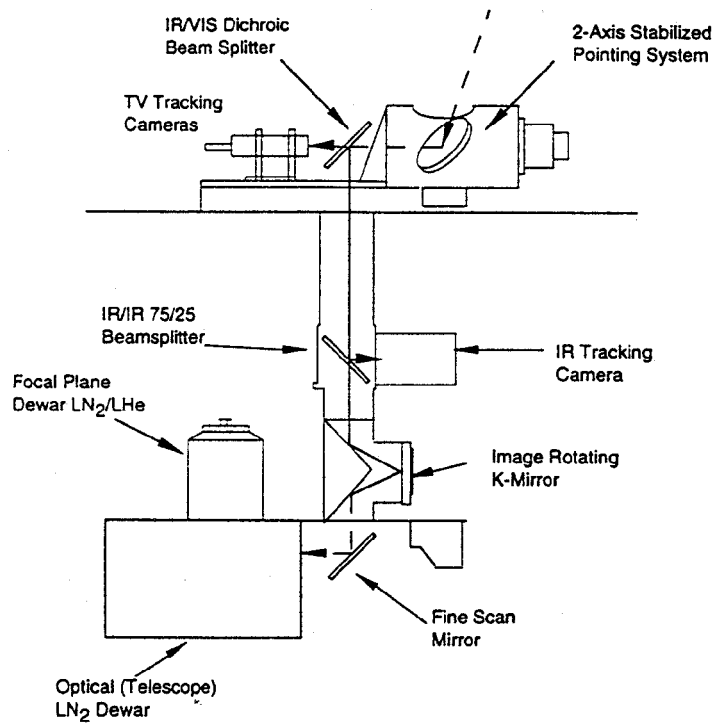


Figure 3. ARES Instrument Optical Path

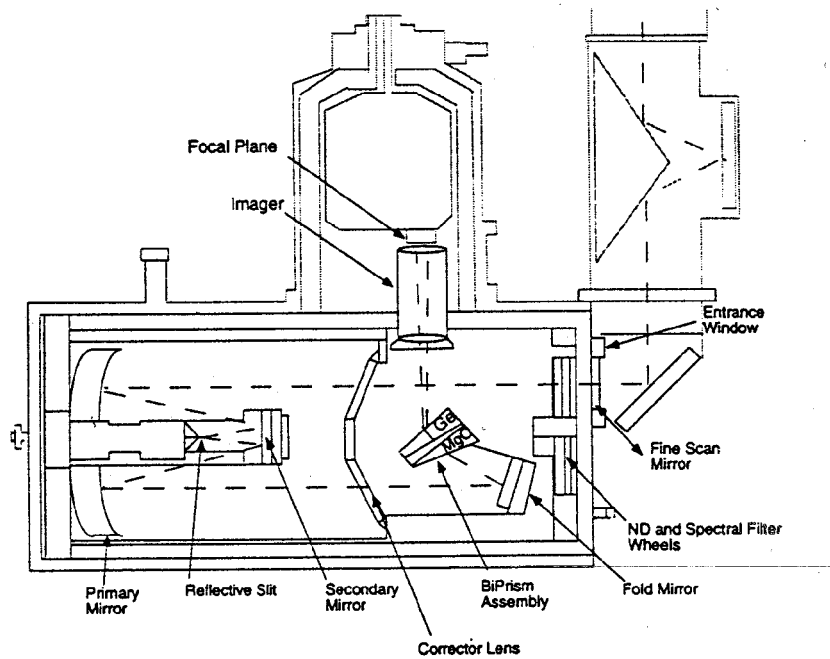


Figure 4. Spectrometer Optics

The fine scan mirror at the entrance to the telescope may be commanded to move up and down, thereby scanning the spectrometer slit across the field of view providing time-varying spatial information. The mirror located above the fine scan mirror is used to rotate the image so that the spectrometer slit scan is normal to the desired scan direction.